

LEAD FRAME CHIP SCALE PACKAGE

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BACKGROUND INFORMATIONField of the Invention

The present invention relates to integrated circuit packages, and more specifically, to the production of a chip scale integrated circuit package using a lead frame.

Related Art

An integrated circuit (IC) package encapsulates an IC chip, or die, in a protective casing and also provides power and signal distribution between the IC chip and an external printed circuit board (PCB). A common IC package uses a metal lead frame to provide the electrical paths for that distribution. For production purposes, a lead frame panel 110 made up of multiple lead frames 120 is etched or stamped from a thin sheet of metal, as shown in Fig. 1a. An IC chip 130 is then mounted and wire bonded to each lead frame 120, as shown in Fig. 1b. Wire bonding is typically performed using fine gold wires 140. Each IC chip 130 is then encapsulated in a protective casing 160, which can be produced by installing a preformed plastic or ceramic housing around each IC chip 130, or by dispensing and molding a layer of encapsulant material over all IC chips 130. Next, lead frames 120 are cut apart, or singulated, and multiple electrical interconnections are attached to the lead frame in order to produce individual IC packages 190, as shown in Fig. 1c. The electrical interconnections provide the electrical interface between IC package 190 and the external PCB, and can take a variety of forms. Fig. 1c

depicts a lead frame ball grid array (BGA) IC package in which electrical interconnections are provided by solder balls 150 mounted on the bottom surface of lead frame 120. Other types of electrical interconnections can be seen in Fig. 1d, which shows examples of common IC packages using lead frames, including a small outline package (SOP) 191, a pin-through-hole (PTH) package 192, and a plastic leaded chip carrier (PLCC) 193.

10 The use of a lead frame provides an inexpensive means for IC package manufacturing. Etching or stamping a sheet of thin metal to produce the desired lead frame patterns is a well-known manufacturing process, and is conducive to high-volume, low-cost
15 production. In addition, the lead frame panel provides a support framework for the IC chips during IC package assembly. However, as IC chip device densities increase and IC package sizes decrease, the geometries used in the electrical communication paths between the
20 IC chip and the PCB decrease. For example, a chip scale package requires that the protective casing be no more than 20% larger than the IC chip. As a result, the area available for the electrical paths provided by the lead frame is significantly reduced, demanding much
25 finer lead frame patterns. In order to construct that finer geometry, the lead frame thickness must be reduced to a point where the lead frame panel rigidity would no longer be sufficient to provide the necessary support during the IC package assembly process. Also,
30 the fragile lead frame patterns would be more susceptible to damage during the manufacturing process. As a result, chip scale IC packages must use more costly techniques such as tape automated bonding (TAB) or printed substrate backing.

Accordingly, it is desirable to provide an IC packaging method that allows the use of a lead frame in a chip scale package.

5 SUMMARY OF THE INVENTION

The present invention provides a method for producing chip scale IC packages using lead frames. A temporary support fixture provides support and stability to a thin lead frame panel having the fine geometries required for higher-density IC chip interfaces. An embodiment of the support fixture includes an adhesive pad made of one-sided sticky tape mounted to a rigid frame made of stainless steel, the rigid frame maintaining the adhesive pad in a fixed configuration providing a stable flat surface for support of the lead frame panel. Alternatively, the rigid frame and adhesive pad can be made of any materials compatible with the IC package manufacturing process and capable of supporting the lead frame panel through the manufacturing process. The adhesive pad can also be patterned to ease the manufacturing process. The rigid frame can include positioning features to assist in the alignment of the lead frame and adhesive pad. If encapsulant material is to be dispensed over the lead frame panel, a containment dam can be formed around the lead frame after it is installed on the adhesive pad, to provide a boundary for encapsulant material flow.

30 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1a shows a representation of a typical lead frame panel;

Fig. 1b shows a lead frame panel populated with IC chips;

35 Fig. 1c shows a single leadframe BGA IC package;

Fig. 1d shows examples of common IC packages;

Fig. 2a shows an embodiment of a rigid support fixture;

Fig. 2b shows a lead frame panel mounted on an embodiment of a support fixture;

5 Figs. 3a and 3b show a flow diagram of a manufacturing process using a temporary support fixture.

10 Use of the same reference number in different figures indicates similar or like elements.

DETAILED DESCRIPTION

15 The present invention employs a rigid support fixture during the manufacturing process to enable the use of lead frames in chip scale IC packages. An embodiment of a support fixture 200 includes a rigid frame 210 and an adhesive pad 220, as shown in the exploded isometric diagram of Fig. 2a. Because pad 220 is affixed along its border to frame 210, it maintains sufficient tension to provide a stable supporting surface for a lead frame panel 110. By making pad 220 out of a thin, flexible, and electrically non-conductive material, it provides a support structure that will not interfere with the conventional

20 manufacturing processes used in IC package assembly. The size of the interior opening of frame 210 is large enough to allow lead frame panel 110 to be fully supported by pad 220. Multiple IC chips 130 are then installed and wire bonded on lead frame panel 110, as shown in Fig. 2b. Subsequent encapsulation of IC chips 130 in protective casings proceeds as in conventional lead frame processing. If a molded protective casing is to be applied, an encapsulant dam 240 can be constructed around the perimeter of lead frame panel

30 110. Dam 240 can be made of any substantially rigid substance, including premolded plastic, epoxy, or tape,

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and serves to prevent flow of encapsulant material beyond the boundaries of lead frame panel 110. Alternatively, containing measures for encapsulant material could be incorporated into the dispensing
5 mechanism. Once encapsulation is complete, support fixture 200 can be removed, either before or after singulation.

The embodiment of the present invention shown in Figs. 2a and 2b can be constructed from common and
10 readily available materials. Pad 220 can be made from a 3M or Nitto-brand sticky tape used in conventional wafer saw operations. Likewise, a stainless steel ring of the type used in conventional wafer saw operations can be employed for frame 210. However, both pad 220
15 and frame 210 can be implemented in many different ways as well. For example, frame 210 can be constructed from any rigid material compatible with the IC package assembly process, such as copper, aluminum, or even non-metals such as ceramic or plastic. Also, while
20 depicted as a thin circular element, frame 210 can also take a variety of configurations depending on handling, interface, and user requirements. For instance, frame 210 can include positioning features to ensure consistent alignment for lead frame panel 110 and
25 adhesive pad 220. A circular outline for frame 210 provides compatibility with conventional handling requirements for IC production, but is not a required aspect of the present invention.

Similarly, numerous implementations of adhesive
30 pad 220 are possible. Any material compatible with the IC package assembly process and capable of providing the necessary support to the lead frame panel and IC chips can be used. The sticky tape mentioned previously is a convenient choice due to widespread
35 current usage and availability. The use of one-sided sticky tape enables pad 220 to be applied to the bottom

surface of frame 210 and provide an adhesive surface for mounting of lead frame panel 110, without requiring additional attachment materials or components. Pad 220 can also be patterned by removing selected portions in order to facilitate subsequent assembly operations such as electrical interconnection formation. Removal of pad 220 once packaging is complete can be performed in various ways, depending on the nature of the adhesive material used. A light adhesive material may allow pad 220 to simply be peeled away from frame 110. An alternative bonding agent requires exposure to UV light before removal of pad 220 can take place.

Figs. 3a and 3b show a graphical flow chart illustrating a method for manufacturing a lead frame BGA package using an embodiment of the present invention. The manufacturing process is described in conjunction with the elements described in Figs. 2a-2c. In a step 310 in Fig. 3a, adhesive pad 220 is applied to rigid frame 210 to create support fixture 200. Lead frame panel 110 is then mounted on pad 220 in a step 320. An optional step 330 allows encapsulant dam 240 to be applied around the border of lead frame panel 110 if subsequent encapsulant material dispensing is to be performed. Next, an IC chip 130 is mounted and wire bonded onto each of the lead frames 120 of lead frame panel 110. Continuing the process in Fig. 3b, a step 350 involves dispensing a portion of encapsulant material 170 into the area defined by dam 240 to cover IC chips 130, and then curing material 170 to a desired hardness. In a step 360, pad 220 is removed from lead frame panel 110. Next, in a step 370, a wafer saw operation is performed to singulate lead frame panel 110 into individual IC packages. The singulation process converts the layer of hardened encapsulant material 170 into individual protective casings 160. Finally, in a step 380, solder balls 150 are applied to

desired electrical interconnection locations to complete lead frame BGA IC package 190.

In this manner a lead frame BGA IC package can be produced using a temporary support structure. This enables the production of IC packages using lead frames that would otherwise be too fragile to withstand conventional manufacturing processes. It should be noted that while particular embodiments of the present invention have been shown and described, it will be apparent to those skilled in the art that many modifications and variations thereto are possible, all of which fall within the true spirit and scope of the invention. For example, the wafer saw operation of step 370 can be performed prior to removal of support fixture 200 from lead frame panel 110. Also, solder balls 150 could be applied to lead frames 120 in step 370 prior to singulation. Alternatively, appropriately located openings in adhesive pad 220 would allow solder balls 150 to be applied without removing pad 220. Certain lead frame designs may even allow patterning of pad 220 such that removal is unnecessary. Finally, while the present invention has been described with reference to chip scale IC package manufacturing, it can be applied to any IC package manufacturing process involving lead frames, including non-chip scale and non-BGA IC packages such as SOP's, PLCC's, and PTH packages.